

N O T I C E

THIS DOCUMENT HAS BEEN REPRODUCED FROM
MICROFICHE. ALTHOUGH IT IS RECOGNIZED THAT
CERTAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RELEASED
IN THE INTEREST OF MAKING AVAILABLE AS MUCH
INFORMATION AS POSSIBLE

"Made available under NASA sponsorship
in the interest of early and wide dis-
semination of Earth Resources Survey
Program information and without liability
for any use made thereof."

8.0-10.193

+ 17-126511

JSC-11882

NASA CR-

160645

**LACIE FIELD MEASUREMENTS
DATA ACQUISITION SUMMARY REPORT:
1975 — 1976 CROP YEAR**

(E80-10193) LACIE FIELD MEASUREMENTS DATA
ACQUISITION SUMMARY REPORT, 1975 - 1976 CROP
YEAR (Lockheed Electronics Co.) 29 p
HC A03/MF A01

N80-28790

CSCL 05B

Unclass

G3/43

00193



National Aeronautics and Space Administration
LYNDON B. JOHNSON SPACE CENTER
Houston, Texas
JANUARY 1977

LEC-9970

NR-08-03986

JSC-11882

LACIE FIELD MEASUREMENTS
DATA ACQUISITION SUMMARY REPORT:
1975-1976 CROP YEAR

Prepared By: Lockheed Electronics Company, Inc.
Systems and Services Division

Approved By:



M. McEwen
Manager, LACIE Field Measurements Project

Approved By:



L. F. Childs
Manager, EOD Field Measurements Program

January 1977

LEC-9970

CONTENTS

Section	Page
1. INTRODUCTION.	1
2. TEST SITES.	2
2.1 <u>FINNEY COUNTY, KANSAS (LACIE SEGMENT 1988)</u>	2
2.2 <u>WILLIAMS COUNTY, NORTH DAKOTA (LACIE SEGMENT 1966)</u>	7
2.3 <u>HAND COUNTY, SOUTH DAKOTA (LACIE SEGMENT 1687)</u>	11
3. SENSORS	14
3.1 <u>LANDSAT.</u>	14
3.2 <u>AIRCRAFT SCANNERS.</u>	14
3.3 <u>HELICOPTER-MOUNTED SPECTROMETER.</u>	16
3.4 <u>TRUCK-MOUNTED SPECTRORADIOMETERS</u>	16
3.4.1 JSC TRUCK SYSTEM	16
3.4.2 LARS TRUCK SYSTEM.	16
4. SUPPORTING MEASUREMENTS	17
4.1 <u>ITS.</u>	17
4.2 <u>EXPERIMENT FARMS</u>	18
5. FIELD CALIBRATION	18
6. DATA ACQUIRED	20

PRECEDING PAGE BLANK NOT FILMED

TABLES

Table	Page
I SENSOR SPECIFICATIONS AND OPERATIONAL CHARACTERISTICS.	15
II FINNEY COUNTY, KANSAS, LACIE FIELD MEASUREMENTS DATA ACQUISITION FOR THE 1975-1976 GROWING SEASON	21
III WILLIAMS COUNTY, NORTH DAKOTA, LACIE FIELD MEASUREMENTS DATA ACQUISITION FOR THE 1976 GROWING SEASON.	22
IV HAND COUNTY, SOUTH DAKOTA, LACIE FIELD MEASUREMENTS DATA ACQUI- SITION FOR THE 1975-1976 GROWING SEASON.	23
V LACIE FIELD MEASUREMENTS MISSION SUMMARY, 1975-1976 CROP YEAR. . .	24

PRECEDING PAGE BLANK PAGE

FIGURES

Figure	Page
1 Location of the three LACIE ITSs.	3
2 Location of the Finney County, Kansas, ITS and Garden City Experiment Station. Center point coordinates of the ITS are latitude 38°10.2' N. and longitude 100°43.2' W.	4
3 Aircraft flight lines 8, 9, and 10 at the Finney County ITS. Fields in which periodic observations were made by the Agricultural Stabilization and Conservation Service (ASCS) are shaded. Additional soil and crop measurements (see section 4) were made in fields marked by an asterisk	5
4 Test plots studied at the Garden City Experiment Station. Each plot is 10 by 100 feet.	6
5 Location of the Williams County ITS and Williston Experiment Station. Center point coordinates of the site are latitude 38°19.02' N. and longitude 103°20.52' W.	8
6 Aircraft flight lines 1, 2, and 3 in the Williams County ITS. Shaded fields are those in which ASCS periodic observations were conducted	9
7 Test plots studied at the Williston Experiment Station. Each plot is 12 by 45 feet	10
8 Location of the Hand County, South Dakota, ITS. Center point coordinates of the ITS are latitude 44°35.0' N. and longitude 98°58.1' W.	12
9 Aircraft flight lines 1, 2, and 3 in the Hand County ITS. Fields in which ASCS periodic observations were made are shaded. Additional soil and crop measurements were made in fields marked by an asterisk.	13
10 Diagrammatic representation of field calibration method	19

PRECEDING PAGE BLANK NOT FILMED

**LACIE FIELD MEASUREMENTS
DATA ACQUISITION SUMMARY REPORT:
1975-1976 CROP YEAR**

1. INTRODUCTION

This report summarizes the data collection activities of the Large Area Crop Inventory Experiment (LACIE) Field Measurements Project during the 1975-1976 crop year.

The main function of the LACIE Field Measurements Project is to acquire, process, and distribute data to users in LACIE. The data consist of annotated, calibrated, multitemporal, spectral (0.4- to 15-micrometer) measurements from several sensors with supporting agronomic and meteorological observations. LACIE field measurements data sets are used in studies which address (1) fundamental LACIE problems, (2) the definition of future multispectral sensor systems, and (3) the development of advanced data processing and analysis techniques. A comprehensive description of the project is given in the *Project Plan* which, at the time of preparation of this report, was being revised to describe 1976-1977 crop year activities. Data are stored in a facility at the Laboratory for Applications of Remote Sensing (LARS) at Purdue University. A series of catalogs (one for each crop year) describes in detail the field measurements data available in the LARS facility.

2. TEST SITES

Data were acquired at three locations in the U.S. Great Plains (fig. 1): Finney County, Kansas; Williams County, North Dakota; and Hand County, South Dakota.

2.1 FINNEY COUNTY, KANSAS (LACIE SEGMENT 1988)

The Finney County supersite (fig. 2) consists of a 5- by 6-mile intensive test site (ITS) and the Kansas State University Agriculture Experiment Station near Garden City, referred to as the Garden City Experiment Station. This test site is in the area of major U.S. winter wheat production. Figure 3 shows the ITS annotated with the aircraft and helicopter flight lines as well as those fields in which ground measurements were made. Figure 4 is a map of the plots measured at the Garden City Experiment Station.

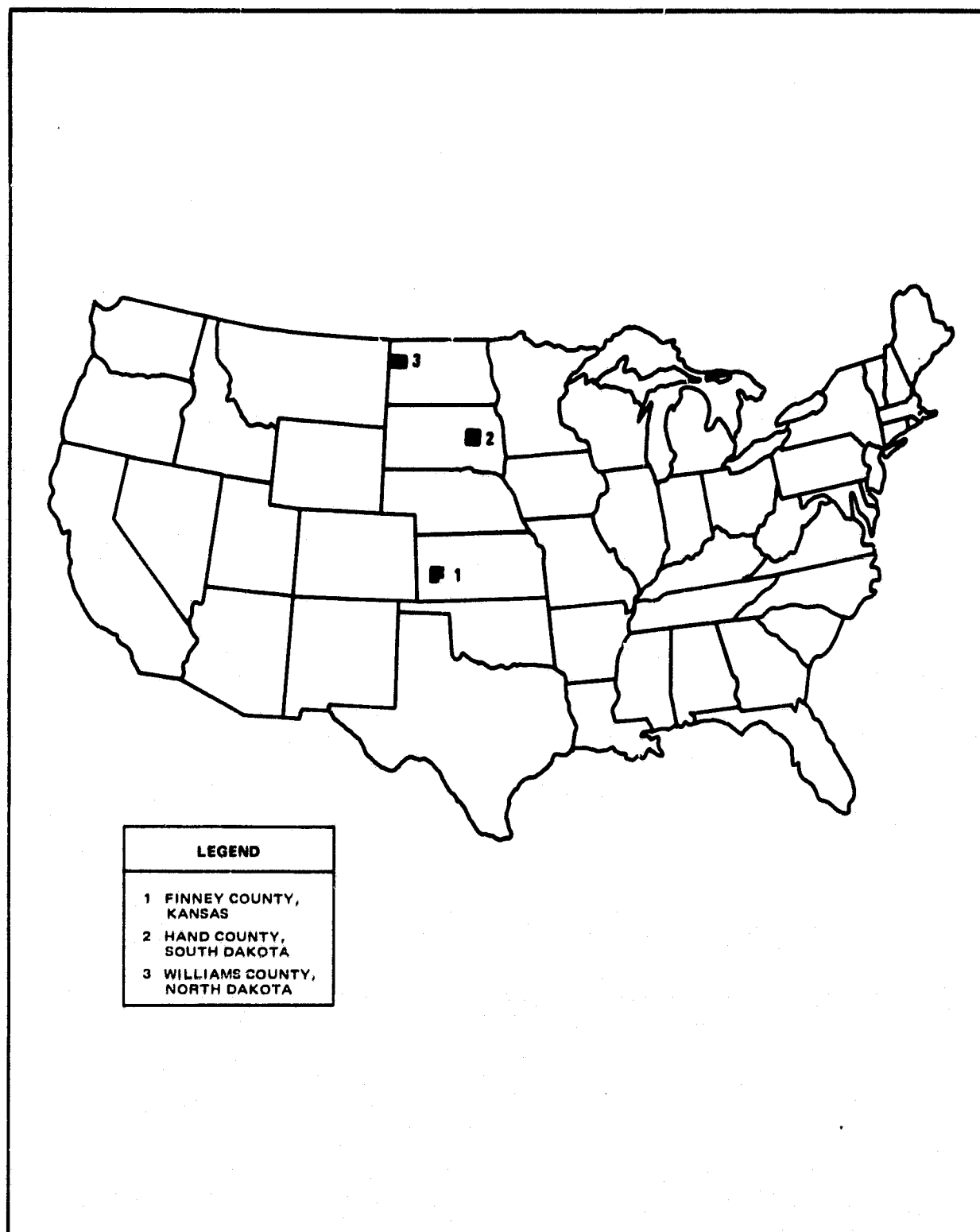


Figure 1.— Location of the three LACIE ITSs.

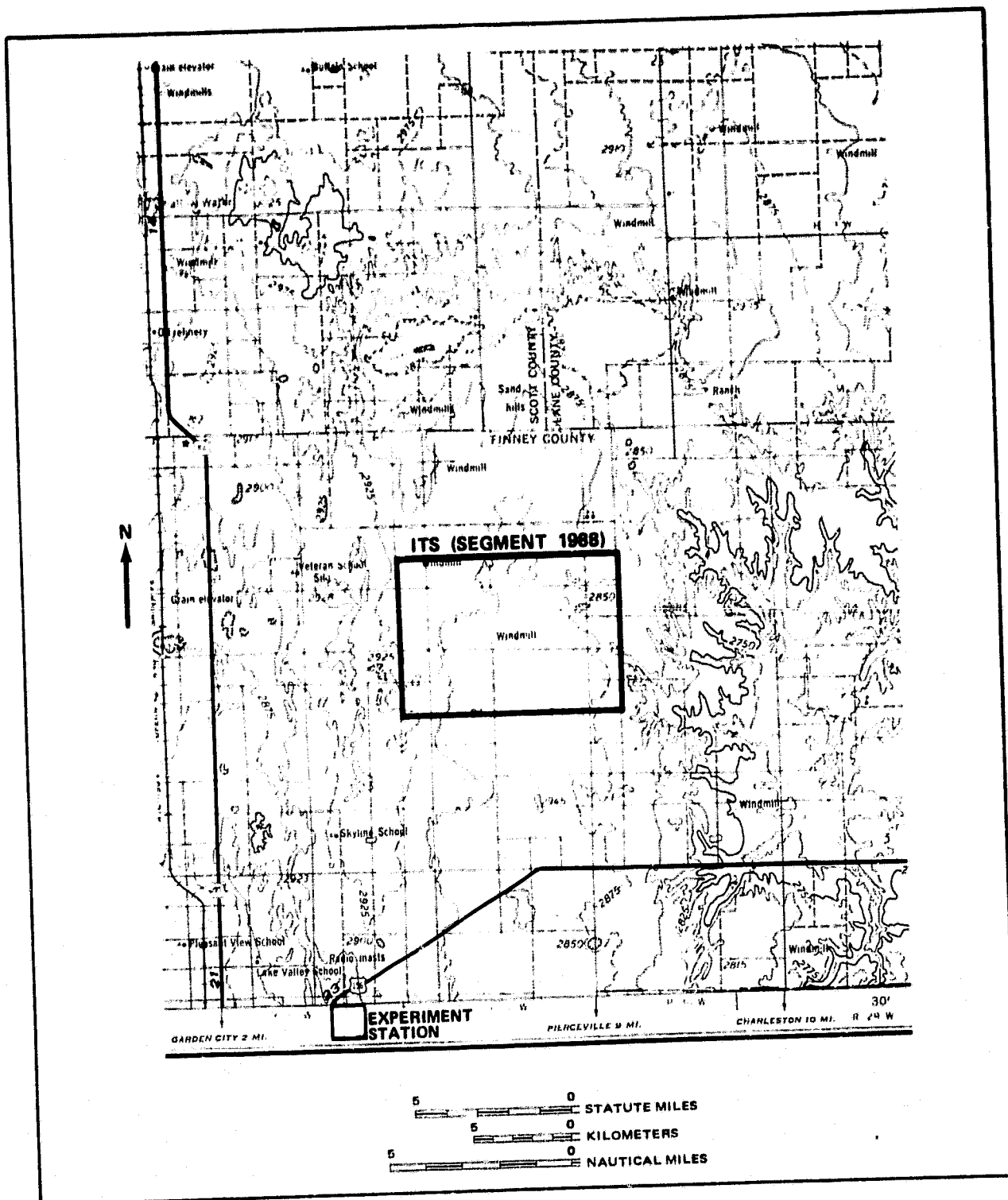


Figure 2.— Location of the Finney County, Kansas, ITS and Garden City Experiment Station. Center point coordinates of the ITS are latitude $38^{\circ}10.2'$ N. and longitude $100^{\circ}43.2'$ W.

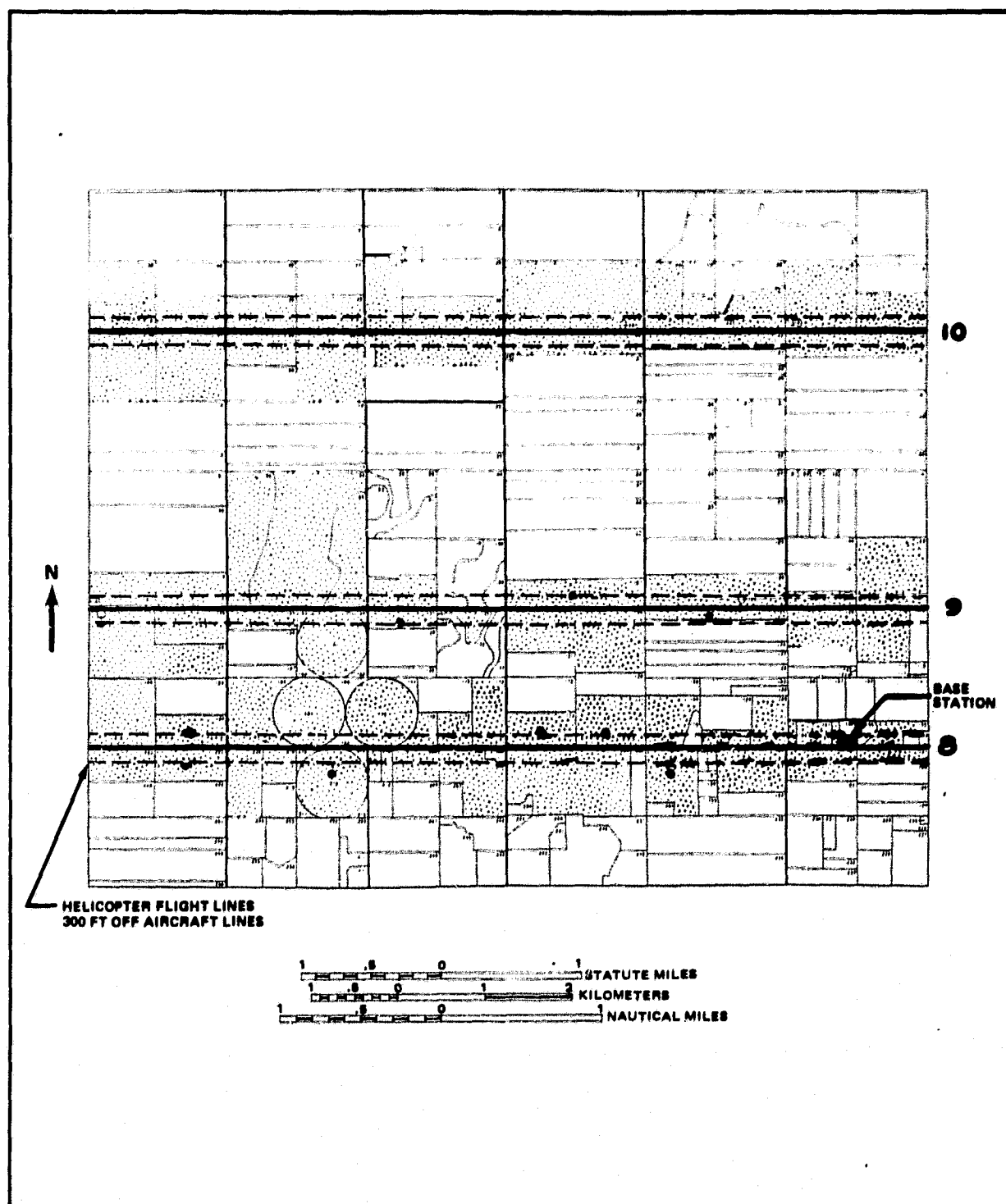


Figure 3.— Aircraft flight lines 8, 9, and 10 at the Finney County ITS. Fields in which periodic observations were made by the Agricultural Stabilization and Conservation Service (ASCS) are shaded. Additional soil and crop measurements (see section 4) were made in fields marked by an asterisk.

2.2 WILLIAMS COUNTY, NORTH DAKOTA (LACIE SEGMENT 1966)

The Williams County supersite (fig. 5) consists of a 5- by 6-mile ITS and the North Dakota State University Agriculture Experiment Station at Williston, referred to as the Williston Experiment Station. This ITS is in the spring wheat growing area of the United States. Figure 6 shows the ITS annotated with the aircraft and helicopter flight lines and indicates the fields in which ground measurements were made. Figure 7 is a map of the plots measured at the Williston Experiment Station.

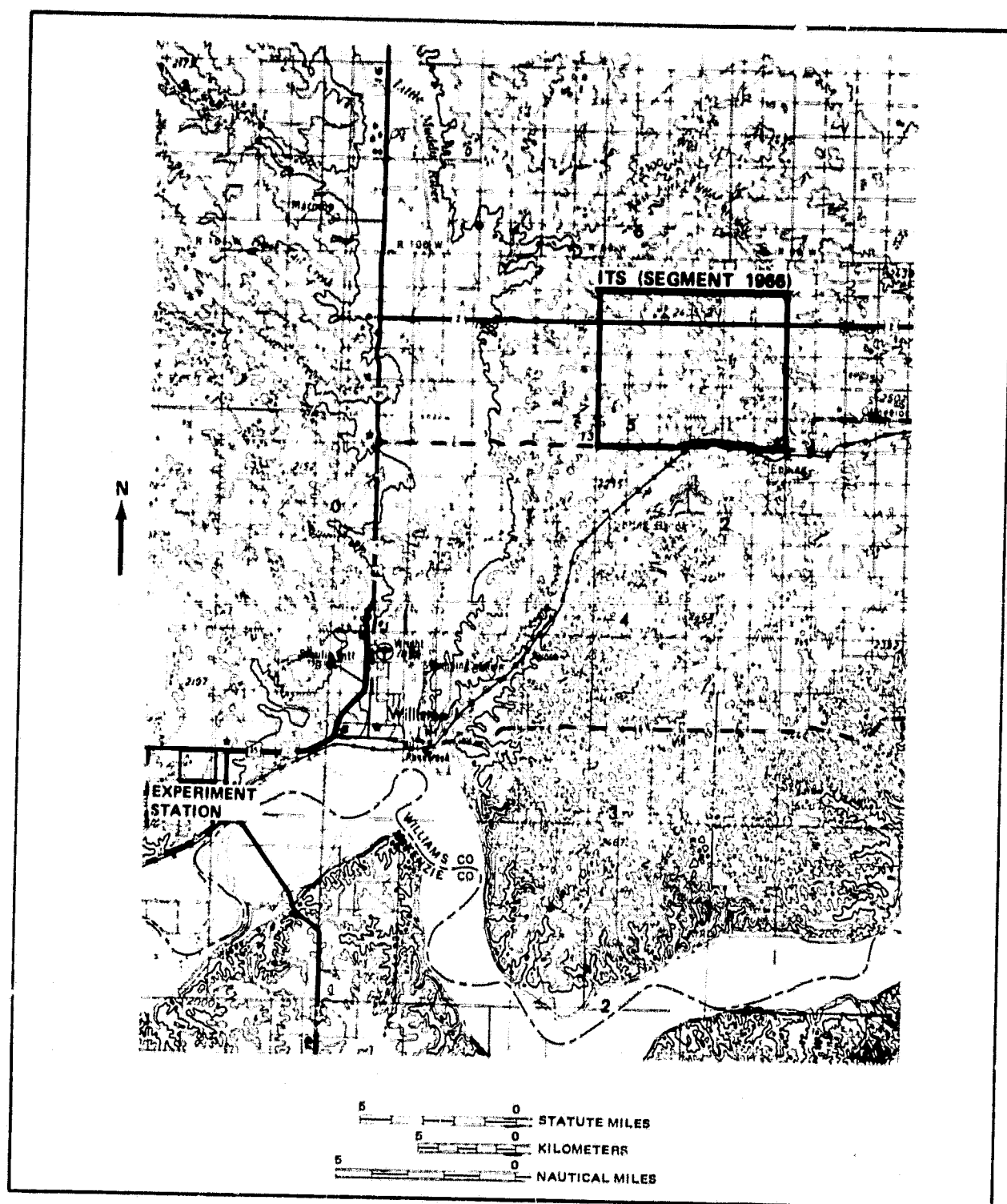


Figure 5.— Location of the Williams County ITS and Williston Experiment Station. Center point coordinates of the site are latitude $38^{\circ}19.02'$ N. and longitude $103^{\circ}20.52'$ W.

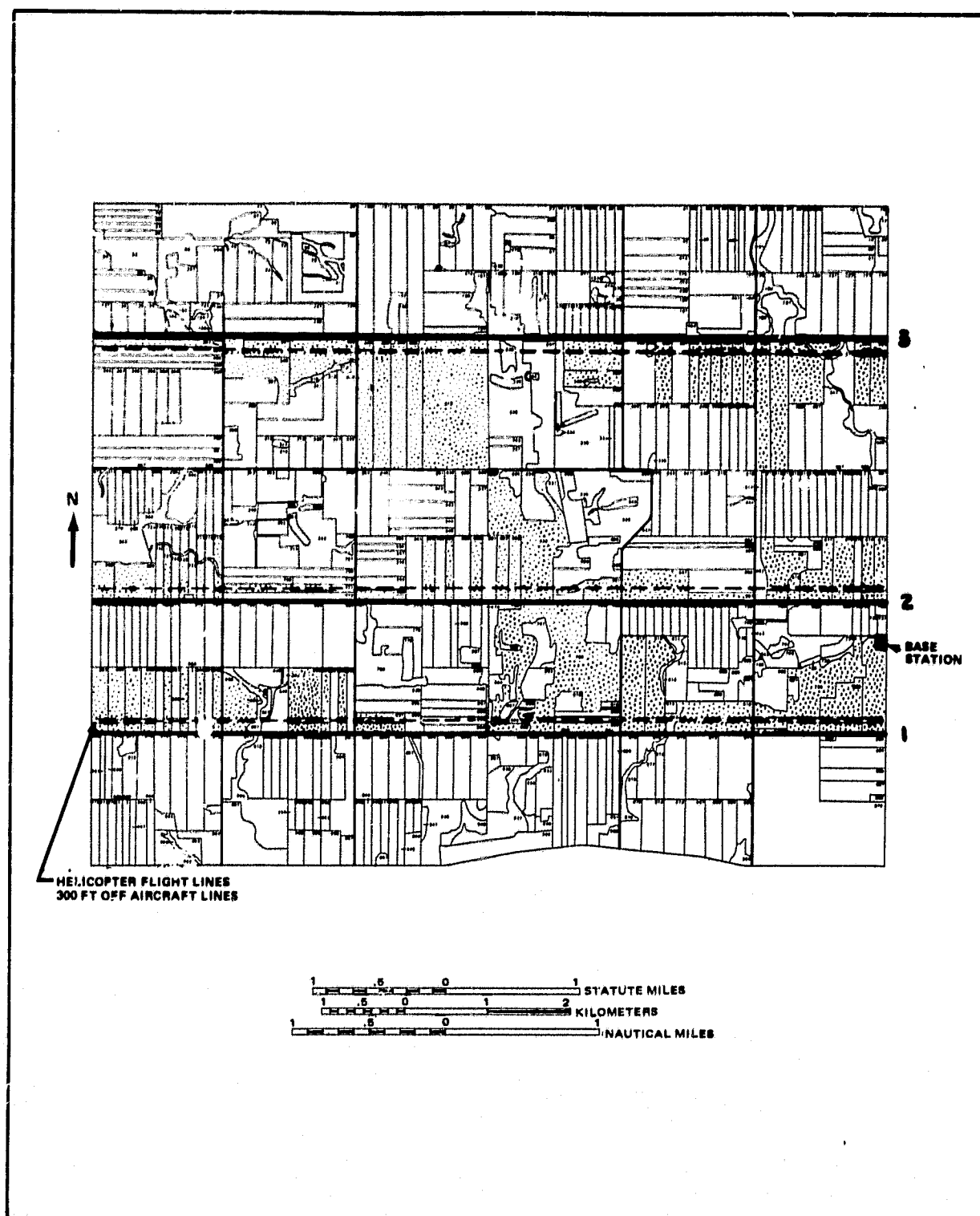


Figure 6.— Aircraft flight lines 1, 2, and 3 in the Williams County ITS. Shaded fields are those in which ASCS periodic observations were conducted.

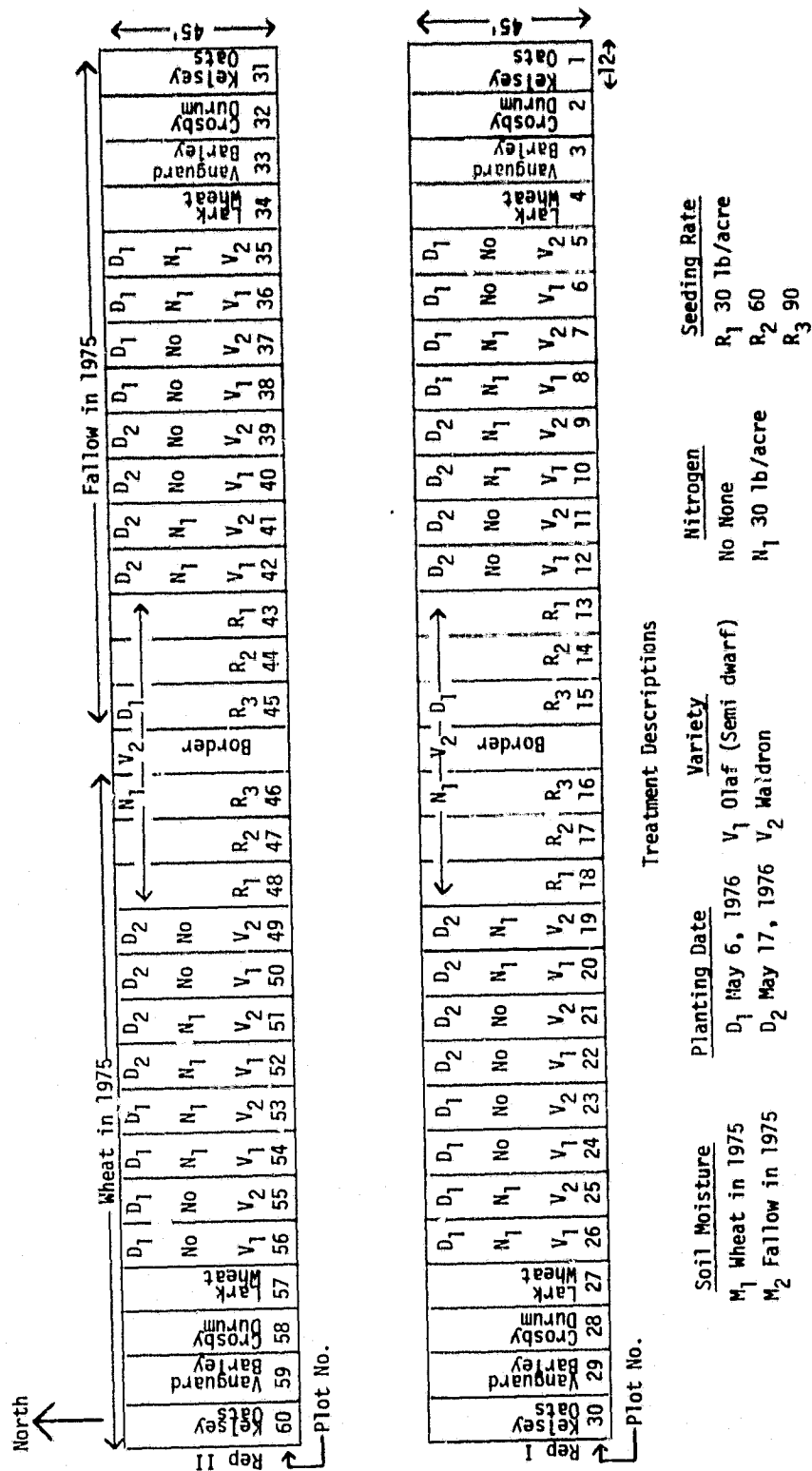


Figure 7.— Test plots studied at the Williston Experiment Station. Each plot is 12 by 45 feet.

2.3 HAND COUNTY, SOUTH DAKOTA (LACIE SEGMENT 1687)

The Hand County supersite (fig. 8) consists only of the 5- by 6-mile ITS; there is no agriculture experiment station in the area. The site is in the transition zone between winter wheat and spring wheat growing areas and includes both types of wheat. Figure 9 shows the ITS annotated with aircraft and helicopter flight lines and indicates the fields in which ground measurements were made.

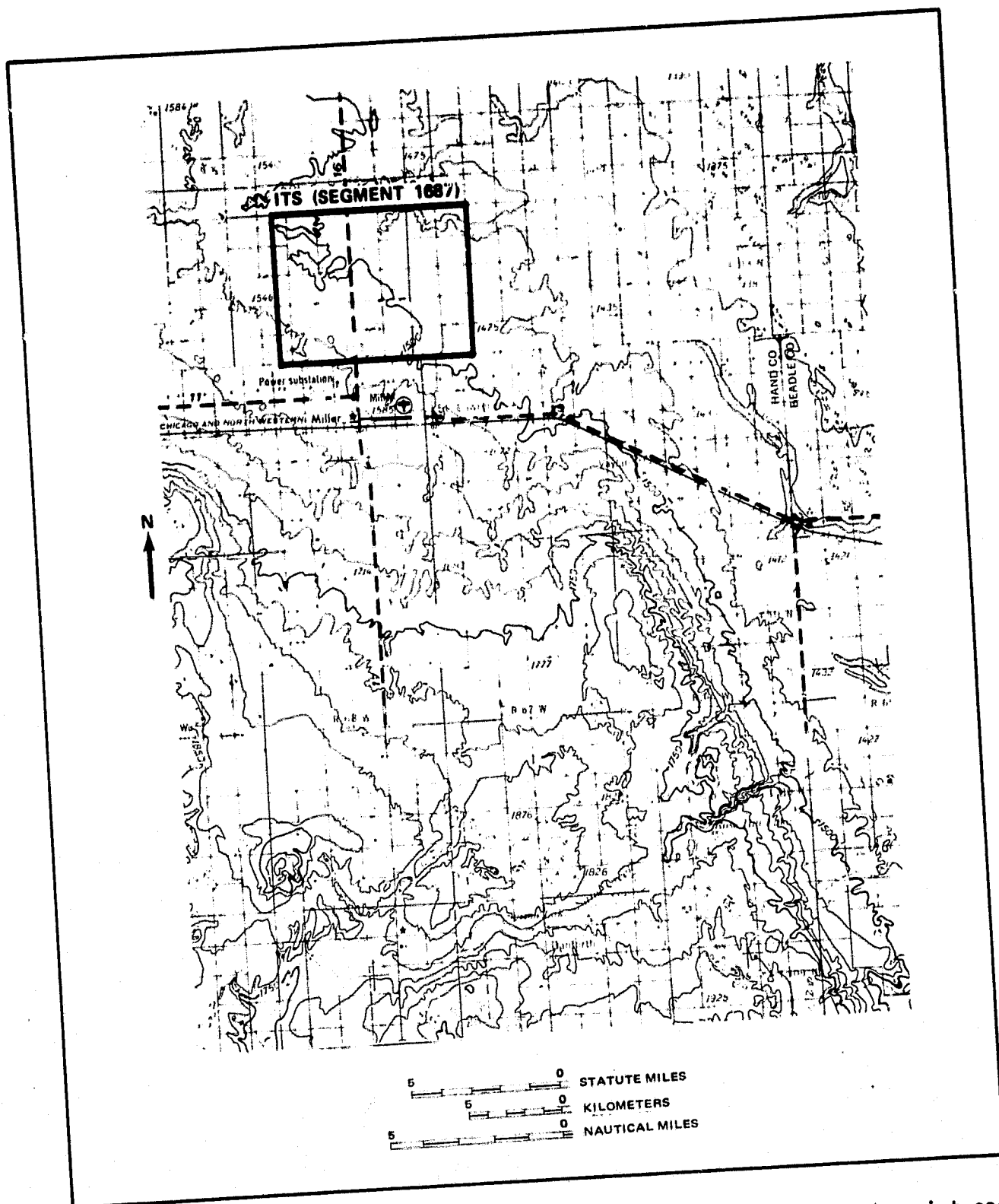


Figure 8.— Location of the Hand County, South Dakota, ITS. Center point coordinates of the ITS are latitude $44^{\circ}35.0'$ N. and longitude $98^{\circ}58.1'$ W.

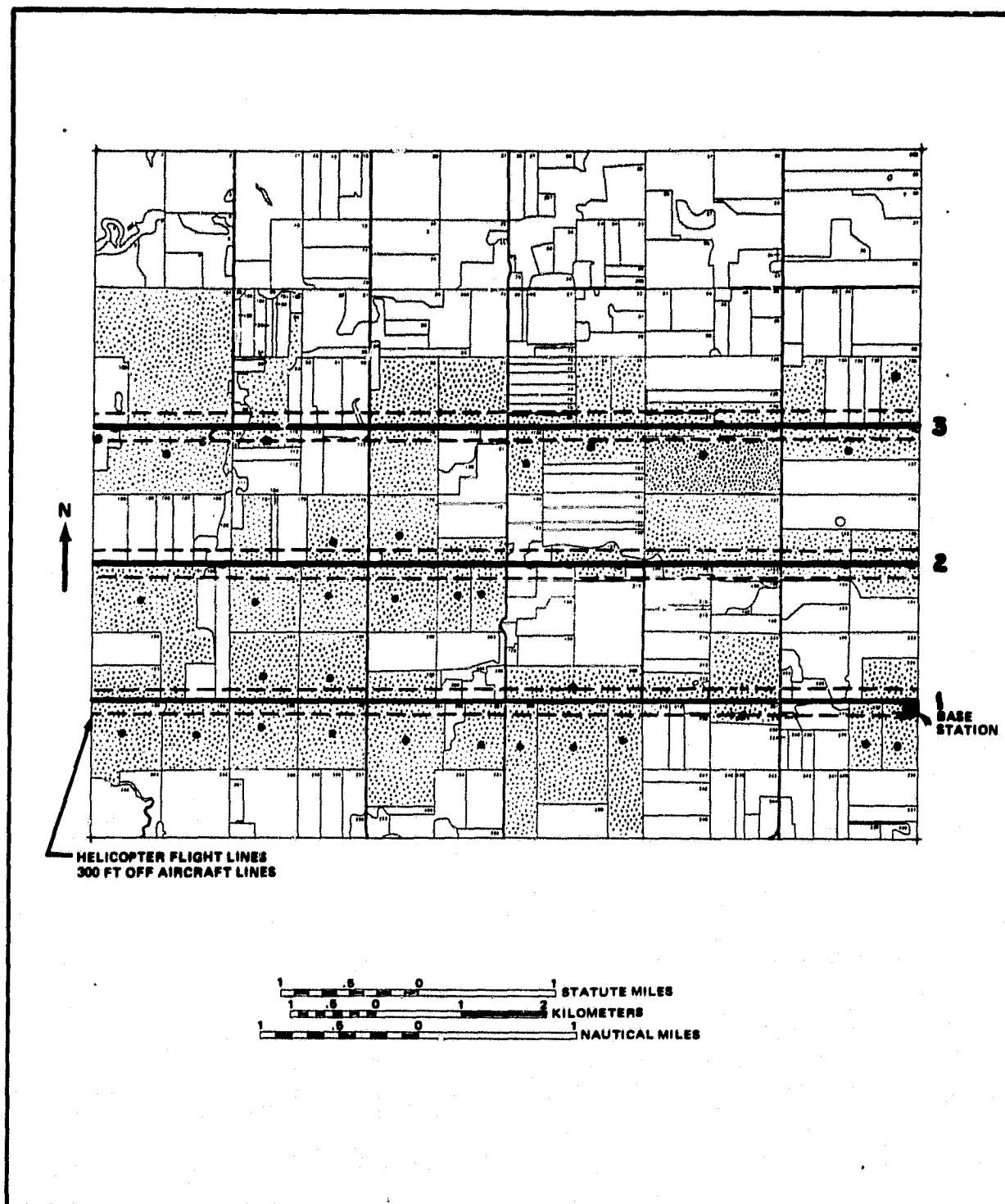


Figure 9.— Aircraft flight lines 1, 2, and 3 in the Hand County ITS. Fields in which ASCS periodic observations were made are shaded. Additional soil and crop measurements were made in fields marked by an asterisk.

3. SENSORS

The major sensors used in LACIE field measurements are listed in the following sections. Their characteristics are summarized in table I. A description of each of the sensors is available at the LACIE field measurements data bank at LARS.

3.1 LANDSAT

Multispectral scanner (MSS) data acquired by both Landsat 1 and 2 at each supersite have been placed in the field measurements data library for those overpasses that occurred when cloud cover was 50 percent or less. Included are the following:

- 9-track computer-compatible tapes (CCTs)
- Black-and-white transparencies of each band
- Color-composite transparency

3.2 AIRCRAFT SCANNERS

Both a 24-channel MSS and an 11-channel modular multispectral scanner (M^2S) were used to acquire data. The MSS has 24 bands — 11 bands between 0.34 μ and 1.09 μ , 6 bands between 1.12 μ and 4.75 μ , and 7 bands between 6 μ and 13 μ . The M^2S has 10 bands between 0.41 μ and 1.1 μ plus one thermal channel $\approx 10 \mu$ to 12 μ . Aircraft data include:

- 9-track CCTs (scene radiance)
- 9-inch color and color-infrared photographs
- 70-millimeter, six-band Airborne Multispectral Photographic System photographs obtained over Hand County only
- Flight logs
- Photo logs

TABLE I.— SENSOR SPECIFICATIONS AND OPERATIONAL CHARACTERISTICS

SPECIFICATIONS				OPERATIONAL CHARACTERISTICS			
Sensor	Type	Spectral bands	Spectral range, micrometer	Spot size IFOV, ft	Swath width, ft	Altitude of operation, ft	Site of operation
Landsat MSS	Imagery	4	0.5 to 1.1	259 × 187 (1.1 acre)	6.1 × 10 ⁵	3.6 × 10 ⁶	ITS
Aircraft MSS	Imagery	24	0.34 to 0.50 0.53 to 1.09 1.12 to 1.73 2.1 to 4.75 6.0 to 13.0	40 20 3	33 560 16 780 2 500	20 000 10 000 1 500	ITS ITS ITS; experiment station
Aircraft M2S	Imagery	11	0.4 to 1.1 10.0 to 12.0	50 25 3.8	47 640 23 835 3 575	20 000 10 000 1 500	ITS ITS ITS; experiment station
Helicopter FSS	Non-imagery	(a)	0.4 to 2.5 6.0 to 16.0	~78	(a)	200	ITS
FSAS	Non-imagery	(a)	0.4 to 2.5 3.0 to 5 } not 8.0 to 14 } used	3.9 to 5.8	(a)	20 to 30	Experiment station
Exotech	Non-imagery	(a)	0.4 to 2.4 2.8 to 14.0	5.4	(a)	20	Experiment station

^aNot applicable.

3.3 HELICOPTER-MOUNTED SPECTROMETER

A helicopter-mounted filter wheel spectrometer, the Field Spectrometer System (FSS), covers the spectral range 0.42 μ to 2.5 μ and 6.0 μ to 16 μ . Data include:

- Flight logs
- 70-millimeter boresight color photographs
- 9-track CCTs (bidirectional reflectance)
- Microfilm tabulation of data on CCTs

3.4 TRUCK-MOUNTED SPECTRORADIOMETERS

3.4.1 JSC TRUCK SYSTEM

The JSC truck-mounted system, the Field Signature Acquisition System (FSAS), is capable of acquiring spectral data in the ranges of 0.4 μ to 2.5 μ , 3.0 μ to 5.0 μ , and 8 μ to 14 μ ; only the 0.4- μ to 2.5- μ capability has been used in acquiring LACIE data. FSAS data include:

- 9-track CCTs (bidirectional reflectance)
- 35-millimeter color transparencies (vertical and oblique)

3.4.2 LARS TRUCK SYSTEM

The LARS truck-mounted system, an Exotech spectrometer, acquired spectral data in the ranges of 0.4 μ to 2.4 μ and 2.8 μ to 14 μ . Exotech data include:

- 9-track CCTs (bidirectional reflectance)
- 35-millimeter color prints (vertical and oblique)

4. SUPPORTING MEASUREMENTS

The following sections list the supporting measurements performed at the ITSs and experiment stations. An inventory of all fields is performed, once in the spring and once in the fall. Periodic observations of fields under flight lines are conducted approximately every 9 days during the growing season.

4.1 ITS

At all large fields (shaded) under the flight lines (see figs. 3, 6, and 9), the following observations were made:

- a. Crop species
- b. Cultural practices: fertilization, planting date, etc.
- c. Crop maturity
- d. Plant height
- e. Ground cover
- f. Stresses: disease, insects, moisture deficits, etc.
- g. Field operations: cultivation, harvesting, etc.
- h. Vertical and oblique photographs
- i. Grain yield

At selected fields (see figs. 3 and 9) under the flight lines, the following additional observations were made:

- a. Leaf area
- b. Fresh and dry biomass
- c. Canopy modeling photographs
- d. Leaf transmittance and soil reflectance
- e. Yield measurements
- f. Soil moisture samples

The following measurements, performed at a base station at each site, coincide with each helicopter and aircraft flight:

- a. Percent cloud cover and type
- b. Temperature
- c. Relative humidity
- d. Wind speed and direction
- e. Barometric pressure
- f. Sky brightness
- g. Total irradiance
- h. Optical depth

4.2 EXPERIMENT FARMS

Data sets at the Garden City Experiment Farm include all supporting measurements identified in section 4.1 and are listed on the individual FSAS tape headers.

Data sets at the Williston Experiment Farm include all supporting measurements identified in section 4.1, except for sky brightness and optical depth. The supporting measurements are listed on the individual Exotech tape headers.

5. FIELD CALIBRATION

Spectral data acquired by LACIE field measurements are normally calibrated back to equivalent bidirectional reflectance (ρ) as shown in figure 10.

- a. A pressed BaSO_4 laboratory standard is used to calibrate the reflectance of painted BaSO_4 field standards.
- b. The BaSO_4 field standard is then used to calibrate the 20- by 40-foot canvas panel calibration standard with both the FSAS and Exotech systems.
- c. Scene (field) reflectance is computed by ratioing the canvas calibration panel radiance to the scene radiance.

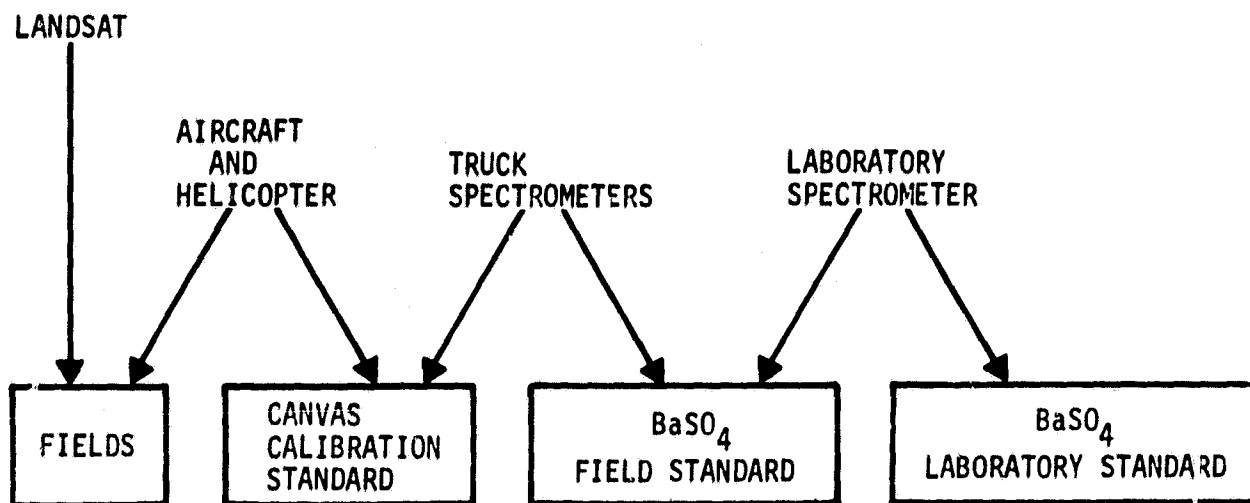


Figure 10.— Diagrammatic representation of field calibration method.

All sensors used have internal housekeeping data to monitor their stability during the data acquisition period.

6. DATA ACQUIRED

The 1975-1976 crop year data acquired in the LACIE Field Measurements Project are given in tables II, III, and IV. The aircraft, helicopter, and truck-mounted spectrometer data collection periods (windows) at the Finney and Williams ITSs were planned to coincide with Landsat overpasses or on the nearest clear day if overpass day was cloudy. Because the satellite passes over Hand and Finney Counties on the same day, no attempt was made to acquire spectral data coincident with the satellite overpass of Hand County. A summary of the missions planned versus the actual data acquisition is given in table V.

TABLE II.—FINNEY COUNTY, KANSAS, LACIE FIELD MEASUREMENTS
DATA ACQUISITION FOR THE 1975-1976 GROWING SEASON

Mission	Wheat growth stage	Landsat		Aircraft scanner		FSS	FSAS experiment station
		1	2	MSS	M ² S		
Sept. 14-17	Pre-emergence		X		X	X	
Oct. 2-6	Seedling		X			X	X
Oct. 20-23	Seedling		X			X	X
Nov. 11-12	Tillering			X		X	X
Mar. 13-19	Tillering		X		X	X	
Mar. 30 to Apr. 2	Tillering		X			X	X
Apr. 9-10	Jointing	X					
Apr. 18-21	Jointing		X		X	X	X
Apr. 27-28	Jointing	X					
May 4-7	Pre-boot		X		X	X	X
May 14-16	Boot	X					X
May 24-26	Heading		X				X
June 2-3	Milk	X					
June 11-13	Dough		X			X	X
June 20-21	Ripening	X					X
June 29 to July 2	Mature		X				
July 8	Post-harvest	X			X	X	X

TABLE III.— WILLIAMS COUNTY, NORTH DAKOTA, LACIE FIELD MEASUREMENTS
DATA ACQUISITION FOR THE 1976 GROWING SEASON

Mission	Wheat growth stage	Landsat		Aircraft scanner		FSS	Exotech experiment station
		1	2	MSS	M ² S		
May 10-14	Emergence		X		X	X	
May 20	Seedling	X					X
May 27-30	Seedling		X			X	
June 2-7	Tillering	X					X
June 16-21	Jointing		X			X	
June 25	Boot	X			X	X	X
July 4-10	Heading		X		X	X	
July 13-17	Dough	X					X
July 20-23	Ripening		X		X	X	
July 28-31	Mature	X				X	
Aug. 6-12	Harvest		X			X	X
Aug. 17-20	Post-harvest	X			X	X	

TABLE IV.— HAND COUNTY, SOUTH DAKOTA, LACIE FIELD MEASUREMENTS
DATA ACQUISITION FOR THE 1975-1976 GROWING SEASON

Mission	Wheat growth stage	Landsat		Aircraft scanner		FSS
		1	2	MSS	M ² S	
Sept. 16-25	Pre-emergence				X	
Oct. 15-16	Emergence					X
Oct. 22-30	Seedling					X
Nov. 5-6	Tillering				X	X
Apr. 26-29	Jointing	X				
May 6-7	Jointing		X			
May 10-16	Stem extension	X			X	X
June 1-4	Heading	X				X
June 12-14	Milk		X			
June 19-23	Dough	X			X	X
June 30 to July 1	Ripening		X			
July 8-10	Harvest					X
July 31	Post-harvest				X	
Aug. 11	Post-harvest				X	X

TABLE V.— LACIE FIELD MEASUREMENTS MISSION SUMMARY, 1975-1976 CROP YEAR

Sensor	Finney County, Kansas	Hand County, South Dakota	Williams County, North Dakota	Total
Aircraft scanners (MSS or M ² S)				
Planned	12	9	12	33
Acquired data	6	6	5	17
Helicopter FSS				
Planned	12	9	12	33
Acquired data	10	8	9	27
Truck systems				
FSAS				
Planned	12	(a)	(a)	12
Acquired data	11	(a)	(a)	11
Exotech				
Planned	(a)	(a)	8	8
Acquired data	(a)	(a)	7	7

^aNot applicable.